

Kingston Ash Recovery Project Ecological Monitoring and Assessment: A Case Study in Adaptive Management

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(and a host of others, but most notably Suzy Walls and Rob Crawford)

What is Adaptive Management?

- Different meanings, depending on context, discipline

For this Project:

- Review results as close to real-time as possible
- Revise monitoring/assessment approach to address deficiencies, optimize use of resources
- Use results of data review & analysis to adapt monitoring & assessment approach to project needs (but not necessarily changes due to changing on-site operations)

Adaptive Management for Kingston

- Public Water Supply, Residential Well Monitoring
- Groundwater Monitoring
- Ash/Sediments Characterization
- Air Quality Monitoring
- Surface Water Monitoring
- Biota Impacts Assessment
- Sediment Toxicity Assessment
- ORAU-Managed Independent Research Projects

Adaptive Management for Kingston

- “Very high altitude” descriptions for several
- “Slightly lower altitude” for a few
- Application in developing Long-Term Monitoring Plan

Method Detection Limit Reporting

August 2009: Reviewed data collected to that point

- Commercial lab Reporting Limits (RLs) not adequate
- RLs typically 3 to 5 times MDLs
- Annual RL, MDL certification typical for commercial labs
- Reported Adverse Effects Levels often < RLs

September 2009: Issued project-specific MDL reporting requirements to contract labs

- Report all results to MDLs
- Run three standards between MDL and RL with each batch of analyses to improve confidence in low-level quantitation

Intense, immediate concern: Possible ash contamination?

Public water supplies:

- First two weeks: TVA sampled TN River at Kingston raw water intake
- First year (until 12/26/09): Kingston and Rockwood Treatment Plant personnel sampled raw & treated water daily; TDEC sampled weekly
- Second and third years: Kingston and Rockwood Treatment Plant Personnel sampled raw & treated water weekly; TDEC sampled monthly

Private wells:

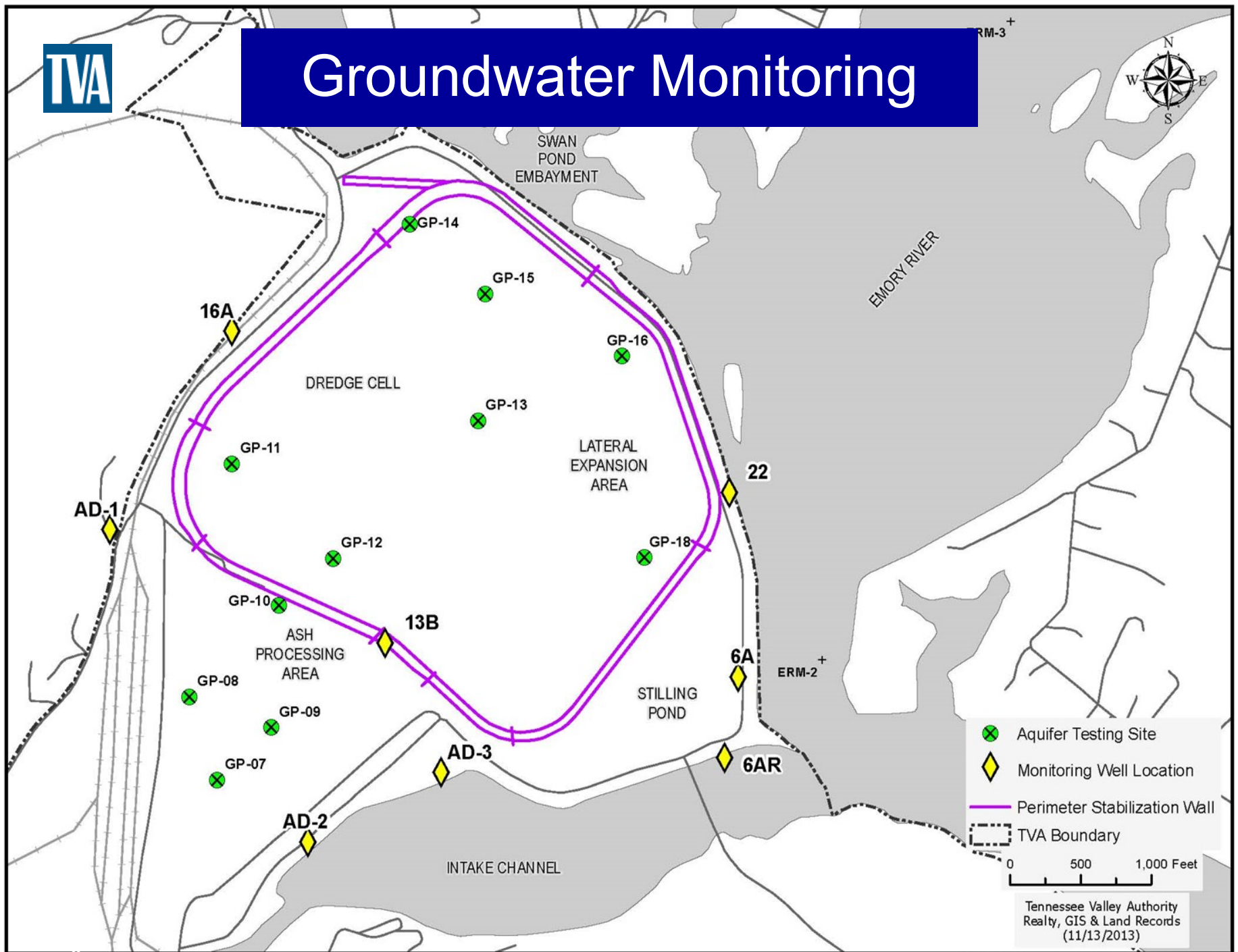
- First week: TVA sampled a few private wells adjacent to plant
- First year: TDEC sampled private wells in a 4-mile radius for the first six months, then 20 “sentinel wells” quarterly for six months

Adapted pre-spill GW compliance monitoring:

- Increased sampling frequency to quarterly (monthly for several wells during high-volume dredging)
- Added analytes not required for normal compliance monitoring
- Restored and expanded well configuration:
 - Replaced wells destroyed by spill
 - Installed additional wells in Ash Processing Area
 - Replaced wells damaged by equipment
 - Installed temporary well points within footprint of dredge cell/ash recovery area to collect data for GW modeling



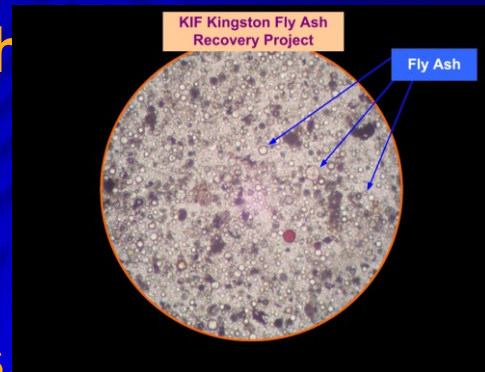
Groundwater Monitoring



Ash/Sediments (aka, "SMASH")

Needed an accurate method to quantify % ash

- Adapted existing PLM point-counting technique for quantifying ash in sediments



Needed a tool to measure ash deposit depths, collect undisturbed sediment/ash samples

- VibeCore-D™ worked for deep cores
- Wildco™ Box Corer penetrated sufficiently for samples <6"



Porewater results inconsistent among research teams

- Developed a simple technique to eliminate atmospheric exposure during sample collection and porewater extraction

Air Quality Monitoring

Again, intense, immediate concern

First six months:

- 24/7 Mobile PM₁₀ monitoring throughout the community
- TVA Air Quality Station deployed on-site for PM₁₀, PM_{2.5}, TSP, and met data; particulates analyzed for multiple COPECs
- Established a permanent network of 5 fixed-stations circling the site plus an off-site TDEC reference station
- Replaced temporary battery-operated monitors (4 sites) with Federal Reference Method (FRM) instruments
- Reduced COPEC list to As, Se, silica

August, 2009 – present:

- Replaced FRM monitors with FR-E Beta Attenuation Monitors (BAMs): data transmitted hourly for posting on website
- April 26, 2010: Moved one station to better capture effects of North Embayment ash recovery activities



Station 13

Air Quality Monitoring



Station 5

ERM-3⁺
Station 7

Station 8

ERM-2⁺

ERM-1⁺

CRM-3⁺

Station 9

CRM-4⁺

ERM-0⁺

CRM-6⁺

Stationary Air Monitoring Locations

0 1,000 2,000 Feet

CRM-5⁺
Tennessee Valley Authority
Realty, GIS & Land Records
(11/13/2013)

Surface Water Monitoring

First two weeks:

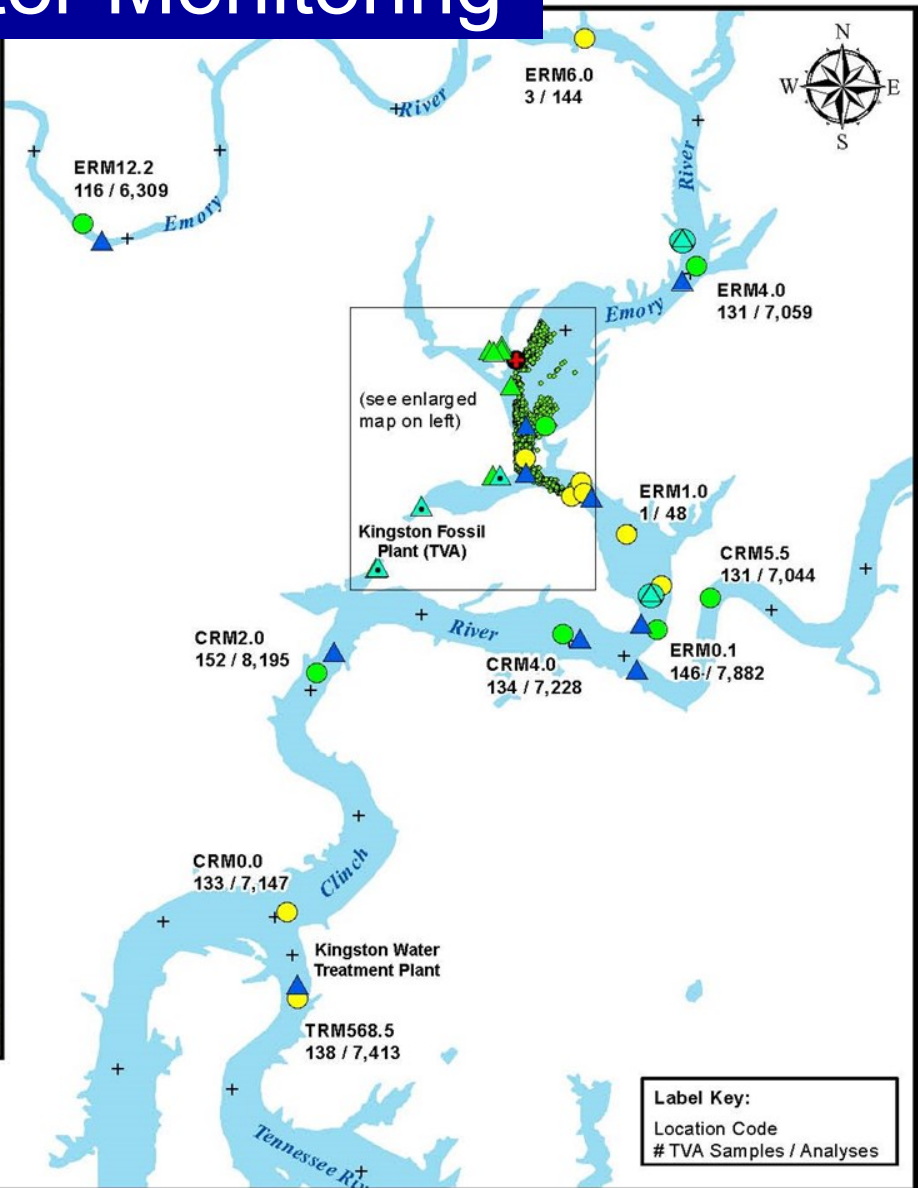
- TVA sampled daily at 11 stations

Beginning January, 2009:

- TVA/TDEC sampled at 11 stations (daily – 7/09; 3-4 times/week – 5/10; weekly – 8/11)
- Floating stations in Emory & Clinch Rivers (2/09 – 8/10); 15-min. data transmission; added auto-samplers 12/09
- Dredge Plume monitoring & sampling (3/09 – 8/10)
- Settling Basin & Clean Water Ditch sampling (7/09 – present)



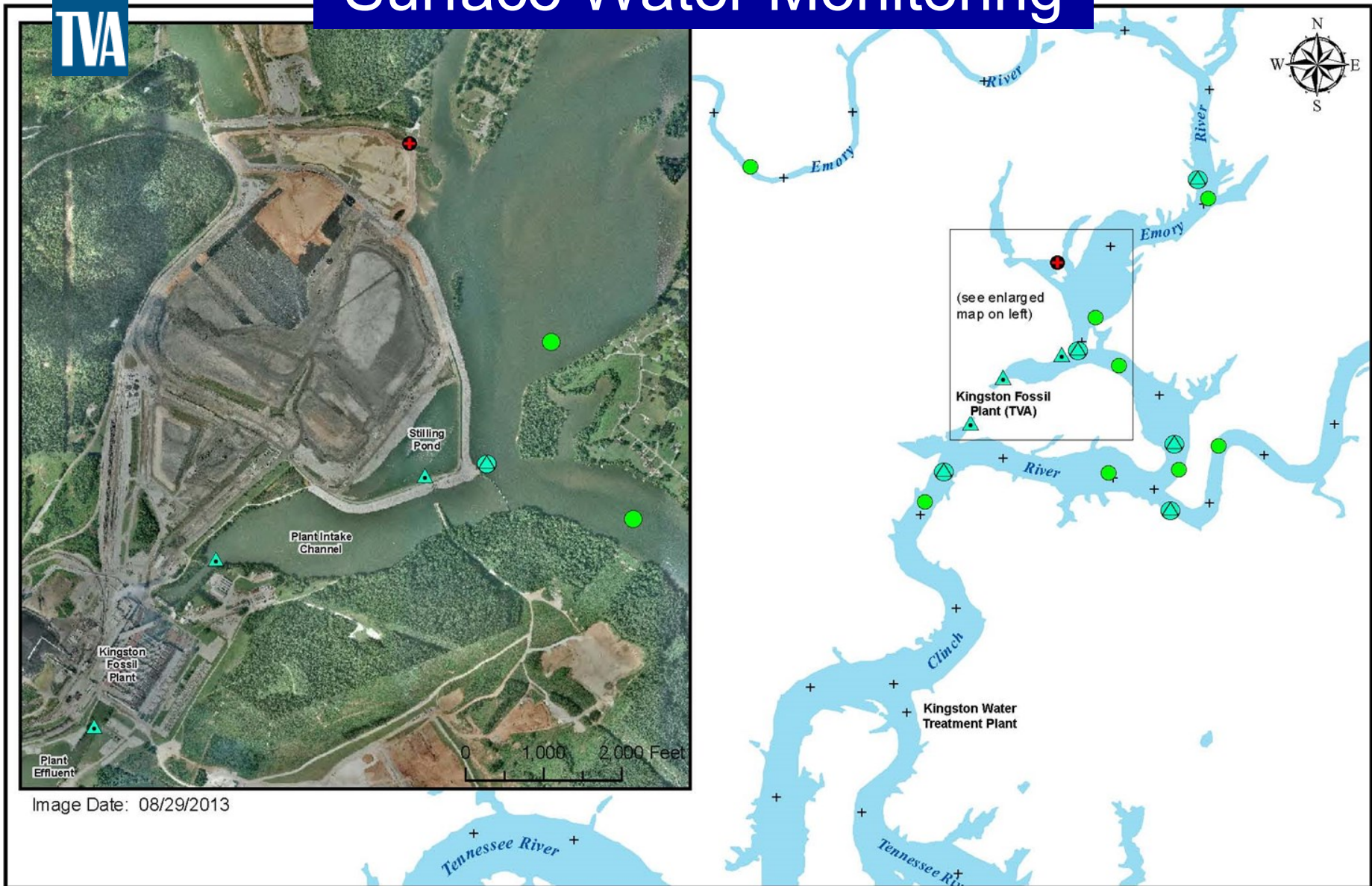
Surface Water Monitoring



- Embayment Auto Sampling
- River Auto Sampler
- ▲ Continuous Hydrolab Monitors
- Plume Surface Water Sample Locations
- ▲ Ash Operations Surface Water Monitoring Points
- Fixed River Surface Water Sample Locations
- Other River Surface Water Sample Locations
- ▲ TDEC River Surface Water Sample Locations

Map Compiled:
14 Nov 2013
Tennessee Valley Authority
Realty, GIS & Land Records
KIF_NRTMonitoring4_20131114_11x8.mxd

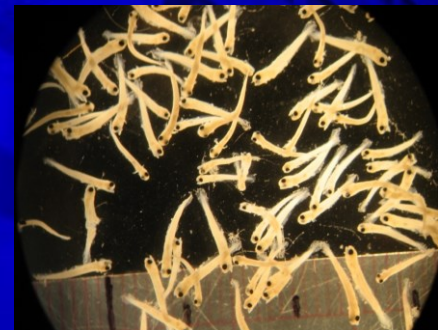
Surface Water Monitoring



- Embayment Auto Sampling
- ▲ Continuous Hydrolab Monitors
- River Auto Sampler
- Fixed River Surface Water Sample Locations

Biota – Fish

- Began collections within a month of spill
- Initial targets: catfish, bluegill, and largemouth
- Later added shad (lower trophic level) and red ear sunfish (higher Se bioaccumulation)
- Dropped catfish and shad in 2011 based on analysis of results
- Laboratory investigations of bioaccumulation and effects on larval fish, plus one larval fish population survey
- Fish health, reproductive competence, histopathology
- Annual fish community surveys



Biota – Birds

- Initially tree swallow, goose, heron, and osprey eggs – dropped goose, heron and osprey based on low concentrations in eggs;
- Focused on tree swallows: bioaccumulation in multiple tissues, analysis of tree swallow diet, reproductive competence.



Biota – Turtles

- Initial target species was snapping turtles; poor trapping success switched focus to stinkpots, with other species (sliders, soft-shells, snappers, map turtles) captured opportunistically
- Bioaccumulation in blood, shell, claw, eggs and hatchlings
- Reproductive competence, population characteristics
- Sub-lethal effects: Lab-incubated hatchling stimulus responses



Primarily bioaccumulation:

- Benthic invertebrates
- Amphibians
- Spiders
- Mammals
- Aquatic/emergent plants



Sediment Toxicity Assessment

- Multiple types of toxicity bioassays during course of project
- Spring 2009: Long-term elutriate tests performed by USACE-ERDC under both aerobic and anaerobic conditions
- Spring 2010: Special study to separate apparent physical and chemical effects observed in early whole sediment tests
- 2011: Residual ash toxicity evaluation – short-term screening tests (no dilution) to identify a subset of sites for definitive tests (long-term, serial dilutions)
- 2013, 2017: 10-d *Hyalella* definitive tests part of long-term monitoring following evaluation of 2011 results

Long-Term Monitoring Plan

- Performed comprehensive data review
- Used collected data in risk assessments
- Focused on areas with most ash, potential for sediment transport, organisms identified as having greatest exposure and risk

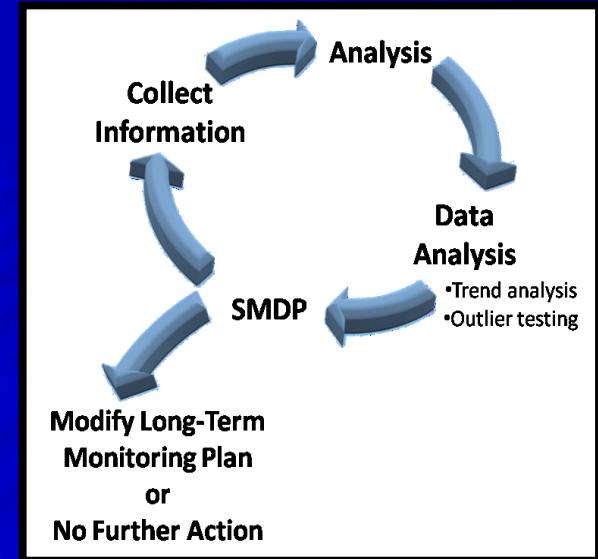


Result -- LTM Components:

- Sediment toxicity: ERM 1, CRM 3
- Sediment transport modeling, sediment surveys after 10-yr high-flow events
- Benthic bioaccumulation and community surveys
- Tree swallows at ERM 1, Tennessee River reference site
- Fish bioaccumulation, fish community surveys to provide supplemental info for NRDA

Long-Term Monitoring

- Scheduled periodic reviews
- Data to be reviewed as it becomes available
- Each evaluation = decision point: “Are follow-up studies or changes needed?”
 - *Continue long-term monitoring plan unchanged?*
 - *Conduct off-year follow-up investigations of unusual results?*
 - *Adjust sampling locations, frequencies?*
 - *Discontinue parts of monitoring plan?*
 - *Adopt newer, more effective monitoring tools?*
 - *Revise plan? No further action needed?*



Acknowledgements

In case you were wondering, this has been quite a team effort...





Acknowledgements



US Army Corps
of Engineers

